A NEW CYNIPID FROM ARIZONA.

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(PLATE II.)

Aulax chrysothamni, new species.

Male and Female. — Head rufous, vertex piceous in the female, wholly black in the male, very finely and minutely punctate. Antennæ rufous in the female, piceous in the male. Thorax black, very minutely and evenly punctate, subopaque; parasidal grooves obliterated anteriorly, very fine posteriorly and convergent at the scutellum. Anterior lines from the collar very indistinct and scarcely reaching the middle of the thorax. Median groove from the scutellum wanting. Pleuræ finely striate. Scutellum black, rugose, with two pit-like depressions at the base. Abdomen black in both sexes. Legs rufous. Wings hyaline, with dark brown veins. Length of male 1.50 mm.; of the female 2 to 2.50 mm.

Gall. — Polythalamous. White, densely covered with white felt-like substance. Elongated, rounded or club-shaped, enlargements of the terminal twigs of the branches of a species of *Chrysothamnus* (*Bigelovia*), measuring from 15 to 30 mm. in length and 12 to 20 mm. in diameter. Sometimes two or three galls are in a row on the same branch. Internally the gall is white and of a pithy substance.

Habitat. — Tucson, Arizona (Gneomar von Krockow).

IS MUTATION A FACTOR IN THE PRODUCTION OF VESTIGIAL WINGS AMONG INSECTS?*

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The application by zoölogists of experimental methods to the investigation of the varied problems of evolution has become so general during the past few years, that entomologists have almost entirely neglected to search in any other way for facts bearing on the mutation theory of De Vries.

The wealth of insect species and the constancy of their specific characters render them more available for non-experimental work of this sort than probably any other group of living organisms.

It is with the hope of calling attention to this interesting field that I have been tempted to present the following scattered observations on

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several groups of insects in which we find a degeneration of the wings. All the higher groups of insects are normally winged, but there are here and there a few restricted groups which have developed genera or species that are partially, almost, or even completely apterous.

In a former paper (The Structure and Significance of Vestigial Wings among Insects, Biol. Bull., Vol. 4, pp. 179–190) I have presented very briefly some more general conclusions concerning insects with vestigial wings. The present one deals only with a few special cases which seem to have some bearing on the principles of natural selection and mutation as applied to the evolution of these organs.

The all-sufficiency of natural selection to explain the origin of all wingless insects was granted by Darwin, and has been accepted by later investigators with an occasional slight protest. Thus, in 1891 Casey (Ann. N. Y. Acad. Sci., Vol. 6, p. 65) referring to the constancy of vestigial wings says:

"It seems extremely difficult to account for this constancy on the theory of natural selection, and, as it is impossible to doubt the ever-acting reality of the principle in question, we can only infer that rudimentary vestigial organs are not necessarily inordinately variable, and when comparatively constant, that the standard is maintained by the action of other laws less easily appreciated."

That we cannot hope to explain all cases of this sort by natural selection alone, I am firmly convinced from the few groups that I have examined. This is especially true of many genera of partially wingless beetles where the wings are protected beneath a sheath composed of the fused and immovable elytra. Thus enclosed between the wing covers and the body they are entirely without influence either physiologically on the animal itself, or externally in relation to its environment. Yet, under these conditions, we find them to be remarkably constant specific characters although not at all uniform within the range of many of the genera.

Several of the cases to be noted in the sequel point very strongly toward the occurrence of mutations in the origin of vestigial wings, while others, so far as I can see, require the assumption of distinctly orthogenetic or determinate tendencies in the degeneration of these structures.

The coleopterous family Carabidæ furnishes numerous interesting cases of wing degeneration which are in strong contrast to the well-developed condition of the wings among the majority of the family.

One genus, *Pasimachus*, is particularly noticeable on account of its large species of peculiar form which are almost completely apterous. In nine North American species which I have been able to examine, the size and shape of the wings is remarkably constant (see fig. 1). In this respect all closely resemble *Pasimachus punctulatus* Hald., the wings of which are figured in a previous paper. They are from three to four and one half millimeters in length, or about one third the length of the elytron, with a distinctly broader basal and suddenly narrower apical portion. So far as my observations go, they are narrowest in *subsulcatus* Say and broadest in *strenuus* Lec.; *costifer* Lec. shows the most marked distinction between the narrower and broader parts. None have any trace of a venation except for a slight costal thickening basally. Thus throughout this entire genus the wings are extremely reduced in size, yet peculiarly constant.

This constancy of form in all the species would seem to indicate that the type of wing must have been acquired before the more recent origin of the present species from a common stock, and that it has been perpetuated without any change during the later differentiation of these species, unless we are willing to grant the presence of a determinate evolution which has brought all to the same form more or less independently.

The extensive genus *Calosoma* belonging to the same family exhibits an

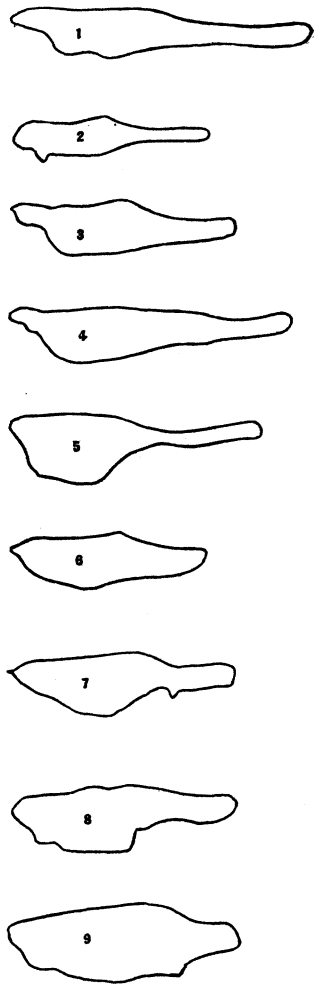

FIG. 1. Outlines of hind wings in nine species of *Pasimachus*. 1. *P. marginatus* Fabr.; 2. *P. subsulcatus* Say; 3. *P. elongatus* Lec.; 4. *P. duplicatus* Say; 5. *P. costifer* Lec.; 6. *P. sublævis* Beauv.; 7. *P. depressus* Fabr.; 8. *P. punctulatus* Hald.; 9. *P. strenuus* Lec.

entirely different condition from that prevailing in *Pasimachus*. It is very widely distributed and represented in temperate North America by about twenty-five species, some twenty of which I have had the opportunity to examine.

Of the entire number, seven (*C. haydeni* Horn, *C. subæneum* Chd., *C. moniliatum* Lec., *C. discors* Lec., *C. wilkesi* Lec., *C. luxatum* Say, and *C. latipenne* Horn) are practically apterous, their wing vestiges being hardly visible without the aid of a lens. The distribution of these ranges northwestward from Kansas, and the wingless forms reach their maximum development in the northern Pacific states. Nearly all (except *C. haydeni*, which I have not seen) form a well marked group definable on characters aside from winglessness, and in all, the elytra show the characteristic anchylosis which absolutely prevents the raising of the elytra above the body and thus precludes even an attempt at flight. In *C. palmeri* Horn, the wings are also short, and reach only about two thirds the length of the elytra, being only eight millimeters in length. This species, too, has the elytra anchylosed although it does not fall into the group containing the wingless species.

Aside from the subapterous forms, an interesting condition is to be seen among some members of the genus which are capable of flight. Two of our most common species in the eastern United States, *C. scrutator* Fabr. and *C. calidum* Fabr., show in the wings differences which are evidently adapted to their different habits. The former is diurnal, and to a great extent arboreal, ascending trees to obtain the caterpillars of which its food consists.

The latter species is terrestrial and nocturnal or crepuscular in feeding habits. This fact is sufficiently evidenced by the frequency with which it is found among the insects eaten by the common toad, while its ability to fly well on occasion is shown by the number attracted to electric street lights in cities on summer evenings. It shows a distinct correlation in its wings which are smaller and more delicate than those of *scrutator*.

In the case of *Calosoma scrutator* and its European congener *C. sycophanta*, the maintenance of strong wings is a necessity or at least a great advantage and comes well within the province of action of natural selection.

On the contrary, the origin of wing vestiges, like those of the various apterous species previously referred to, from a condition of

partial winglessness associated with elytral anchylosis can hardly be explained through the selection of slight variations, or in fact, by selection of any sort. With this single genus at least, we can scarcely imagine how the small wings can be either an advantage or a detriment in any way. It cannot be a matter of the conservation of moisture in the body as has been suggested in connection with certain desert inhabiting Tenebrionidæ, since these species of *Calosoma* seem to be associated indiscriminately with either xerophytic or mesophytic conditions.

Some other genera of Carabidæ contain wingless or subapterous species, but I have not been able to find any which present such continuity as the two just described, although others no doubt exist.

The Tenebrionid genus *Blapstinus* affords another interesting case of a small group of beetles which shows a great range of variation in wing development. It is represented in the United States by nearly fifty species, and reaches its highest development in the southwest. The beetles live in common with most members of the family concealed beneath stones or bark, some species confined to arid regions, others to the warm and moist regions of the Pacific and Gulf coasts, and some to the more temperate regions of the upper austral and transition zones.

The great variety of wing development among the species was first noted by Casey in 1890 (Ann. N. Y. Acad. Sci., Vol. 5, p. 416). He found that the wings vary in length from about one fifth to nearly six fifths of the elytral length, and that they are of almost constant shape and size for each species. Regarding their utility, he says: "In no case do they seem to be large enough, however, to give more than a labored and feeble flight."

In all species except those with the largest wings, the elytra are more or less perfectly anchylosed.

In a second paper published the following year Casey again refers to the constancy of these organs, as follows: "I have recently by way of experiment dissected a series of eight specimens of a form very near *Blapstinus rufipes*, probably a variety or race of that species, and have found a singular and altogether unexpected constancy in the form and size of the rudimentary hind wing, the extreme variation not amounting to more than one fifth of the average length, the latter being a little more than one half the total length of the elytra."

I have been able to examine the wings of a number of species and

have found that they agree with the measurements given by Casey, and to be very constant in the same species, so far as I can determine from the small series of each.

If these organs in *Blapstinus* are of no use for the primary function of flight, and are adapted to no secondary use, it would seem that we must look elsewhere than toward natural selection for the explanation of their origin and maintenance in so many and such constant degrees of degeneration among various species. As we have seen in the several groups previously discussed, this genus forms a very compact series separable only by minute specific differences which are apparently not or very slightly correlated with the variations in the wings.

The abundance of wingless beetles in arid regions has led me in this case to examine rather closely the geographical range and habitat of the various species so far as they have been recorded. I have been unable, however, to detect any positive connection between wing-length and environment with the exception of an apparent, but slight tendency toward smaller wings in desert or dry regions and longer ones in moist or cooler regions. Species with long, and others with very short wings often have overlapping or nearly coincident ranges in both humid and dry regions, but as has been found among other groups of Tenebrionidæ, the distinctly northern or northeastern species have the wings comparatively well developed.

That we have here another case not explainable by natural selection alone, I strongly suspect, while the acceptance of mutation will give at least a plausible explanation of the conditions as we find them.

The species belonging to the Hymenoptera are among the most active forms of insect life, yet we find two large and very many smaller groups where the wings of one sex are regularly absent or more or less atrophied. The more interesting cases from our present standpoint are to be found in the normally winged large groups where certain genera are regularly wingless.

In the Hymenoptera the wings whenever present, even as vestiges, are always entirely external, and never permanently concealed as among the Coleoptera heretofore considered, so that we must be extremely careful in assuming that they can ever be entirely without selective value. Nevertheless the occurrence in precisely similar environments of fully winged and partially or completely apterous species is not at all rare. A genus of small parasitic Hymenoptera, *Megaspilus*, is well represented in this country by a number of winged

species, several subapterous ones, and others entirely destitute of wings. In fact it seems probable that some of the normally volant species are occasionally only partly winged in both sexes. So far as primary function is concerned, a condition of slight reduction in the size of the wings is equivalent to their complete absence, since once below the standard required for flight, they are entirely useless, and hence cannot be of selective value, unless in respect to some secondary function which is extremely rare. Among related families other genera exhibit closely similar conditions, *e. g.*, *Caloteleia*, *Gryon*, *Hoplogryon* of the Scelionidæ; *Loxotropa* of the Diapriidæ, etc.

The occurrence of brachypterous forms of winged species has often been noted in widely separated groups of insects, but is usually the expression of seasonal or sexual dimorphism. At least in the Hymenoptera above referred to, the regular occurrence of these wingless forms without intermediate stages points in the same direction as the cases of wingless beetles, toward the existence of mutation as a factor, and a very prevalent one. It is interesting to note in this connection that Darwin himself mentions certain species of beetles that are normally winged, but which occasionally have vestigial wings.

So-called sports or mutations are not so rare in the wings of Hymenoptera which are completely winged, and there have recently come under my observation several very interesting cases. The first series of three abnormal specimens belong to the same species, *Myzine sex-cincta* Fabr., a member of the aculeate family Scoliidæ. The genus *Myzine* is notable for its strong sexual dimorphism that extends even to the venation of the wings which is very different in the sexes. This is a most remarkable character which is repeated in only a very few instances throughout the entire order with the exception of a few related Scoliid genera which are strongly dimorphic in this respect. In other groups the dimorphism usually affects only a single cell such as the radial.

All three abnormalities are in male specimens (selected from a series of not more than fifty) in which sex the venation also shows in any considerable series of specimens a strong tendency toward continuous variation in the length of certain veins, insertion of recurrent nervures, etc.

That this variation, both continuous and discontinuous is correlated with the sexual dimorphism and the great variability of the related genera seems very probable, and shows that the group as a

whole has an innate tendency toward continuous variation, and also toward variation which presents all the appearances of true mutation.

In one specimen the second section of the cubitus in the right wing is partly wanting; in another the third transverse cubitus is wanting; and in the third a part of both the recurrent nervure and the second transverse cubitus. Two closely related groups in this same family are generically separable by just such characters as those illustrated in the abnormal specimens, for example, *Elis*, *Trielis*, and *Tetrascolia* on the one hand and *Scolia* and *Discolia* on the other. No absolutely positive conclusions can be derived from such facts without experimental study, but the most logical one would seem to be the acceptance of these abnormalities as characters having the attributes of true mutations. That they are in no sense reversions is evident as th general evolutionary trend among Hymenoptera has always been toward reduction from the more complicated venational pattern of the more primitive groups.

A reduction of some sort is the form in which an abnormal character usually manifests itself in the wings of Hymenoptera, and it is very frequently almost perfectly bilateral.

The foregoing facts relating to wingless insects are perhaps no more striking than many others better known, and their principal interest lies in the bearing which they may have on the origin of fixed characters by mutation. I think also that it cannot be questioned that the evolution of these degenerating wings is in a certain sense determinate.

AUGUST LUETGENS.

August Luetgens died on January 21 in his seventy-first year. He was one of the original members of the Brooklyn Entomological Society and the owner of a large collection of Coleoptera in which the fauna of foreign countries was well represented. His collection was remarkable for the extreme care and skill with which the specimens were mounted and labelled. Each specimen was compared with the descriptions and remounted before being placed in the collection.

Mr. Luetgens was a German and a bachelor and had no relations in this country; he was employed as a bookkeeper for over thirty years by one firm; he lived for the same period with one family, and labored incessantly at the arrangement of his collection to which he devoted all his leisure time. He was of a retiring disposition and known to few entomologists in this country, but by them he was justly held in high esteem.